

[001] Device and method for machining workpieces

[002]

[003]

[004] The invention relates to an apparatus and a method for machining a metallic workpiece in strip or plate form, in particular for removing the oxide layer from cut surfaces and/or cut edges of the workpiece.

[005]

[006] An apparatus of the generic type and a corresponding method are known from DE 197 39 895 C2.

[007] During the laser cutting of metallic workpieces, an oxide layer or oxide skin is formed at the cut edges and at the cut surfaces. A drawback of the oxide layer is that a coating applied to it by painting or galvanization flakes off again relatively quickly. For this reason, the metallic workpieces are ground before being painted and galvanized.

[008] A drawback with grinding the cut surfaces or cut edges, i.e. removing the oxide layer from them - an operation also known as descaling - is that it sharpens the cut edges, resulting in an increased risk of injury. Therefore, the cut edges may have to be blunted again after the grinding operation.

[009] The document of the generic type referred to above shows a method and an apparatus for removing the oxide skin from metal blanks. The metal blank is guided between rotating, material-removing machining tools arranged in pairs in order for the oxide layer to be removed from the cut surfaces. Although this method can be used to clean the oxide layer off the outer cut surfaces, it is not possible to remove the oxide layer from inner cut surfaces, e.g. from cutouts or similar apertures in the workpiece. Furthermore, the metal blank has to be fed to a further machining apparatus if the surface or main face of the workpiece also needs to be cleaned.

[010] Further drawbacks of the apparatus of the document of the generic type are the handling and the expensive structure and considerable amount of space taken up. Furthermore, the wear to the machining tools is uneven, since it is generally the case that the metal blanks to be descaled are always introduced in the same region, i.e. at the same location, so that part of the machining tool never comes into contact with the metal blank, while another part of the machining tool is subject to permanent wear.

[011] Furthermore, the general prior art has disclosed apparatuses for deburring and precision-grinding. These use both rollers and plate-like, rotating brush tools. In the known apparatuses, the workpiece which is to be machined is placed on a horizontal working level or a conveyor belt and manually or automatically guided through beneath the roller or the rotating brush tool. As is also the case in the apparatus described in the document forming the generic prior art, the drawback arises that in general the workpieces are always introduced at the same location, leading to uneven wear to the roller or brush tools. Machines of this type may, for example, have a working width of 1 to 2 m, but in practice are generally provided with smaller metal blanks to process. The result of this is that a roller with a length of, for example, 2 m is only exposed to wear from metal blanks over the first 50 cm of its length, and therefore only wears away in this region. The roller has to be replaced as soon as this region has become excessively worn, even though three quarters of the roller surface are still in a good condition and usable. They have to be replaced if only because when a large workpiece is introduced the first 50 cm of the roller are no longer capable of grinding. The uneven wear to the roller and the resulting different pressure on the workpiece have a deleterious effect on the grinding results. In addition, the fact that the penetration depth of the brush or roller is not continuously variably adjustable also has an adverse effect on the quality of deburring or grinding. Inherently useful, deep penetration of the bristles is prevented by the conveyor belt on which the workpiece is resting, since this conveyor belt should not be damaged.

[012] Another drawback of the known deburring and grinding machines is that the workpiece has to be introduced twice, so that both main faces of the workpiece can be machined. A further drawback of the known machines is the high drive power, the considerable amount of space which they take up and the high procurement and maintenance costs. The basic areas of the machines are dimensioned such that even workpieces of the maximum size can be introduced and machined flat. The result of this is that if the machine is intended to machine pieces of metal of a size of  $2 \times 2$  m, the basic area requires at least this amount of space. In addition, there is the space which is required to attach and straighten the piece of metal before it is introduced into the machine and to remove it.

[013] Another drawback of the known grinding machines is that they are either suitable for cleaning or precision-grinding the main surfaces of the workpiece or, like the apparatus of the document of the generic type, for descaling the peripheral edge

of the workpiece. Furthermore, apart from manual machining, there are no known solutions for descaling the internal cutouts, holes, apertures and the like.

[014] Furthermore, the prior art has disclosed expensive and complex wet-grinding processes.

[015]

[016] The present invention is based on the object of resolving the above drawbacks of the prior art, and in particular of providing a fast, simple and inexpensive apparatus and a method for machining metallic workpieces in strip or plate form, in particular for removing the oxide layer from cut surfaces and/or cut edges thereof.

[017] According to the invention, this object is achieved by the fact that there is a rotating conveyor device provided with at least one brush, the conveyor device guiding the at least one brush at least approximately linearly past the region of the workpiece to be machined.

[018] A method for machining a metallic workpiece is given by the characterizing clause of claim 38.

[019] Since the brush, on account of being arranged on a rotating conveyor device, does not dwell rigidly at one position, but rather is guided past the entire length available for the workpiece to pass through, uniform wear to the at least one brush is ensured. The workpiece can in this case easily be guided or pulled through obliquely, preferably transversely, with respect to the direction of rotation of the brush, so that the workpiece is uniformly machined by the brush.

[020] The inventor has discovered that, surprisingly, the linear profile of the brush in the region of the workpiece to be machined ensures that the brush penetrates into all cutouts or holes in the workpiece and therefore removes the oxide layer at all cut surfaces and cut edges. Consequently, the brush moves along the workpiece obliquely or transversely with respect to the direction of advance of the workpiece and penetrates into each cutout, similarly to a paintbrush which is pulled along a piece of metal.

[021] It is advantageous for the apparatus according to the invention to machine the surfaces, i.e. the main surfaces of the metallic workpieces in strip or plate form and also to descale the cut surfaces and cut edges. Simultaneous descaling of the cut surfaces and cut edges and cleaning of the main surfaces was not possible with the apparatuses which have been disclosed hitherto.

- [022] It is advantageous if there are two conveyor devices, between which the workpiece can be guided obliquely or transversely with respect to the direction of rotation, in such a manner that each conveyor device machines one of the two main surfaces of the workpiece by means of the associated brushes.
- [023] As a result, both main surfaces of the workpiece are particularly advantageously machined by a single operation. Moreover, the cut edges and the cut surfaces are machined from both sides, resulting in particularly thorough descaling. The use of two conveyor devices allows the workpiece to be machined quickly and economically.
- [024] Furthermore, according to the invention it is possible to provide for the conveyor devices to have a plurality of brushes arranged at a distance from one another.
- [025] As the inventor has concluded, in a manner which was not obvious, if the conveyor device has a plurality of brushes arranged at a distance from one another, the main surfaces of the workpiece and the cut surfaces and cut edges are machined particularly well and reliably. The fact that there is a distance between the brushes prevents the bristles of the brushes which are at the front, as seen in the direction of rotation, from having bent over the following bristles before they reach the workpiece. This was what happened with the brushes known from the prior art (for example in the case of the rotating "plate brush"). If the following bristles have already been bent over by the preceding bristles, the following bristles can no longer penetrate far enough into cutouts and the like, and consequently the latter are only inadequately cleaned.
- [026] The distance between the brushes ensures that the brushes in each case come into contact with the workpiece in unbent form and advantageously penetrate into cutouts or holes.
- [027] In a refinement of the invention, it is possible to provide for the bristles to be in wavy and/or twisted form.
- [028] A wavy form of the bristles of the brushes ensures that the bristles are not arranged uniformly in a row, but rather irregularly, so that the bristles on the one hand are not impeded to any great extent by bristles located at the front, as seen in the direction of rotation, and on the other hand a particularly high-quality cleaning can be achieved, as has surprisingly been established in tests.
- [029] Advantageous configurations and refinements of the invention will emerge from the further subclaims and from the exemplary embodiments which are outlined below with reference to the drawing.

- [030] Claim 37 reveals a particularly advantageous V-belt for use in the apparatus according to the invention.
- [031] In the drawing:
- [032] Fig. 1 shows a perspective illustration of the apparatus according to the invention with two conveyor devices;
- [033] Fig. 2 shows a front view of the apparatus according to the invention shown in Fig. 1 with two conveyor devices;
- [034] Fig. 3 shows a plan view of the apparatus according to the invention in the direction of arrow III from Fig. 2;
- [035] Fig. 4 shows a side view of the apparatus according to the invention in the direction of arrow IV from Fig. 2;
- [036] Fig. 5 shows a perspective illustration of the apparatus according to the invention with a housing;
- [037] Fig. 6 shows an outline illustration of a workpiece that is to be machined and a substantially vertically running conveyor device with a plurality of brushes in each case arranged on carriers;
- [038] Fig. 7 shows a perspective illustration of an exert from a V-belt with a carrier and bristles shot into it;
- [039] Fig. 8 shows a view of part of a V-belt in the direction of arrow VIII from Fig. 7;
- [040] Fig. 9 shows a plan view of part of a V-belt in the direction of arrow IX from Fig. 8;
- [041] Figs 10a to 10d show various embodiments of the V-belt;
- [042] Fig. 11 shows a perspective illustration of an exert from a V-belt with one form of the carrier comprising segments arranged standing freely;
- [043] Fig. 12 shows a perspective illustration of individual segments of the carrier, it being possible for the segments to be fitted together by means of a tongue/groove connection;
- [044] Fig. 13 shows a side view of a segment of the carrier with obliquely positioned bristles;
- [045] Fig. 14 shows a side view of a segment of the carrier with obliquely positioned bristles and a stabilizing supporting bristle;
- [046] Fig. 15 shows a perspective illustration of a segment of the carrier with a bundle of bristles and a stabilizing sheath;

[047] Fig. 16 shows a perspective illustration of an exert from a V-belt in an alternative embodiment to Fig. 7, with segments arranged standing freely, which are provided with obliquely positioned bristles;

[048] Fig. 17 shows an exert from the conveyor device, with a resistance element in the form of a steel roller downstream of a diversion point, as seen in the direction of rotation; and

[049] Fig. 18 shows a side view of the apparatus according to the invention with four substantially horizontally running conveyor devices.

[050]

[051] Fig. 1 shows an apparatus for machining a metallic workpiece 1 in strip or plate form (illustrated by way of example in Fig. 3 and Fig. 6). The apparatus according to the invention is particularly suitable for removing the oxide layer from cut surfaces 1b and/or cut edges 1a of the workpieces 1. It is possible to descale both peripheral cut surfaces 1b and cut edges 1a of the workpiece 1 and cut surfaces 1b and cut edges 1a of cutouts, holes or the like in the workpiece 1. Tests have shown that small bores generally do not have to be descaled, since they are generally used as screw holes and therefore do not absolutely have to be painted or galvanized.

[052] The apparatus according to the invention can advantageously be used to remove oxide layers or impurities from the two main surfaces 1c or the surface of the workpiece 1, in such a way that reliable and permanent painting or galvanization is possible without the risk of the applied layer subsequently flaking off.

[053] As can be seen from Figs 1 and 2, the apparatus according to the invention has two conveyor devices 2, which are each provided with brushes 3. The conveyor devices 2 guide the brushes 3 at least approximately linearly past the region of the workpiece 1 that is to be machined. The workpiece 1 to be machined is in this case guided or pulled through between the two conveyor devices 2 transversely with respect to the direction of rotation of the conveyor devices 2. For this purpose, the apparatus according to the invention has a guide passage 4, which can also be seen from Fig. 3.

[054] The guide passage 4 can be adapted as a function of the thickness of the workpiece 1 to be machined, by means of an adjustment device 5. To allow the workpiece 1 to be guided through comfortably, the apparatus according to the invention has a sheet-metal feeder 6, by which the workpiece 1 can be introduced into the guide passage 4. After it has passed through the guide passage 4 or the two

conveyor devices 2, the workpiece 1 is released onto a receiving table 7. A metal feed-through plate or the next workpiece 1 can be provided to push through the workpiece 1.

[055] The receiving table 7 can have a vertically running stop which ensures that the workpiece 1 falls or can be turned into a defined orientation when it emerges from the guide passage 4 (cf. Fig. 4).

[056] The guide passage 4 is also designed to guide the brushes 3, so that they move in a defined way along the workpiece 1 and cannot yield outward.

[057] In addition to the adjustment device 5, the apparatus according to the invention has an independent infeed 8, by means of which the depth of penetration of the brushes 3 can be varied. This is advantageous in particular with a view to correcting the wear to the brushes 3 and/or increasing the pressure. In the variant with two conveyor devices 2 illustrated in the exemplary embodiment, these conveyor devices are displaced or adjusted with respect to one another in order to correct the wear to the brush 3. In a particularly simple configuration of the solution according to the invention, having just one conveyor device 2, this conveyor device is displaced or adjusted toward a fixed wall of the guide passage 4, which in this case serves as an abutment or a replacement for the second conveyor device 2. Of course, in this embodiment it is also possible to provide for the guide passage 4 to be adjusted in the direction of the conveyor device 2.

[058] In the exemplary embodiment, it is provided that the adjustment device 5 and the infeed 8 are designed with spindles. The spindles of the adjustment device 5 or the infeed 8 can be connected, in a manner which is not illustrated in more detail, by means of in each case one chain and provided with a worm gear.

[059] As can be seen from Fig. 1 and Fig. 3, the conveyor devices 2 are arranged slightly offset with respect to one another in the direction in which the workpiece 1 passes through. The offset in the direction of passage may in this case be, for example, 10 to 100 mm, preferably 30 mm. This therefore on the one hand ensures that the respective brushes 3 of the conveyor device 2 do not impede one another, and on the other hand also ensures a uniform and balanced pressure of the brushes 3 of the conveyor devices 2, balancing one another so that the workpiece 1 does not tend to become tilted.

[060] In an embodiment which is not shown and in which four conveyor devices 2 are provided, it has also proven advantageous for these devices to be arranged correspondingly offset.

- [061] The solution according to the invention illustrated is a variant in which the conveyor devices 2 are arranged in a standing position, so that the brushes 3 of the conveyor device 2 run substantially vertically in the region of the workpiece.
- [062] Alternatively, the solution according to the invention may, in a manner which is not illustrated, be provided with conveyor devices 2 arranged in a lying position, so that the brushes 3 are arranged so as to run substantially horizontally in the region of the workpiece 1. In this case, it is expedient for the spindles of the adjustment device 5 or the infeed 8, which have to at least partially absorb the weight of the apparatus in the lying position, to be reinforced by mating roller bearings.
- [063] In the exemplary embodiment shown in Fig. 1 to Fig. 5, with the two conveyor devices 2 arranged in a standing position, the direction of rotation of the conveyor devices 2 is selected in such a manner that the brushes 3 of the two conveyor devices 2 can move past the two main surfaces 1c of the workpiece in the same direction. This is illustrated in Fig. 2 on the basis of the running direction of the conveyor device 2 with the four arrows illustrated. This direction of rotation of the conveyor device 2 or the bristles 3 ensures advantageous removal of dirt.
- [064] As can be seen from Fig. 2, the direction of rotation of the conveyor devices 2 is selected in such a manner that the brushes 3 are guided past the workpiece 1 from the top downward or in the direction of a base plate 9 illustrated in Fig. 4. This running direction results in a particularly advantageous removal of dirt and imparts a high level of stability to the apparatus according to the invention and the workpiece 1 to be machined, since the latter is not pushed in an uncontrolled manner by the brushes 3, but rather is pressed in a fixed and stable way onto the base plate 9.
- [065] In a variant of the apparatus according to the invention in which the conveyor devices 2 are formed in a lying position, it is advantageous if the direction of rotation of the conveyor devices 2 is selected in such a manner that the brushes 3 can be guided past the workpiece 1 in the direction of a delimiting plate which guides the workpiece 1 at one end side. In a similar way to the workpiece 1 being pressed onto the base plate 9 in the standing configuration of the conveyor devices 2, therefore, the workpiece 1 is pressed in a stable way onto the delimiting plate.
- [066] Tests have shown that in a configuration of the apparatus according to the invention with four conveyor devices 2, it is advantageous if each of the two main surfaces 1c of the workpiece 1 is machined by in each case two oppositely rotating conveyor devices 2. In this context, to enable the workpiece 1 to be guided through in a particularly stable and reliable way, it is advantageous if the conveyor devices



2, as has already been described, are arranged slightly offset with respect to one another in the direction in which the workpiece 1 passes through. Moreover, it is in this context advantageous if the directions of rotation are selected in such a manner that the brushes 3 of the first conveyor device 2, as seen in the direction in which the workpiece 1 passes through, and of the fourth conveyor device 2 can be guided past the workpiece 1 in the direction of the base plate 9. The second and third conveyor devices 2, as seen in the direction in which the workpiece 1 passes through, therefore run in such a way that the brushes 3 arranged thereon move in opposite directions to the first and fourth conveyor devices in the region of the workpiece 1. This arrangement ensures that the workpiece 1 is pressed downward in the direction of the base plate 9 by the first conveyor device 2, and although the next two conveyor devices 2 press the workpiece 1 upward, this is immediately corrected again by the subsequent fourth conveyor device 2, which presses the workpiece 1 downward again. In this case, the first and third conveyor devices, and the second and fourth conveyor devices, respectively, are in each case arranged on one side of the workpiece 1 or one main surface 1c.

[067] In the case of the lying arrangement of four conveyor devices 2, the advantageous directions of rotation of the conveyor devices 2 are selected in a similar way, with the base plate 9 replaced by a delimiting plate.

[068] Tests have shown that a rotational speed of the brushes 3 of from 5 to 30 m/sec, preferably 15 to 16 m/sec, is particularly advantageous. This speed on the one hand ensures rapid machining of the workpieces 1 and on the other hand has proven suitable in terms of the reliability of machining and the load imposed on the components involved.

[069] In the embodiment of the apparatus according to the invention with two conveyor devices 2 illustrated in Fig. 1 to Fig. 5, it may be necessary for the workpiece 1 to be turned over and pushed through again. This is easy to conceive when considering Fig. 6, since the brushes 3 naturally grind down the side faces 1b or side edges 1a facing the direction of rotation more successfully than the side faces 1b or side edges 1a which are oriented in the opposite direction (i.e. are on the leeward side, so to speak).

[070] In the variant of the solution according to the invention with four conveyor devices 2 illustrated in Fig. 18, in which in each case two conveyor devices 2 brush to the right and two brush to the left, there is no need for the workpiece 1 to be turned over and pushed through again. In the configuration of the solution according

to the invention with four conveyor devices 2, the workpiece is fully machined by a single pass.

[071] In a further variant of the solution according to the invention, which is likewise not illustrated, it is possible to provide an automatic advancement means for passing through the workpieces 1.

[072] In tests, it has emerged that an independent drive for each conveyor device 2 is particularly expedient and, moreover, can be realized in a simple and inexpensive way. In the exemplary embodiment, electric motors 10 are used to drive the conveyor devices 2.

[073] Fig. 5 shows the apparatus according to the invention with a housing 11. Both the sheet-metal feeder 6 and the receiving table 7 can be designed to be of adjustable height. In this context, it is also possible to provide for the width of the sheet-metal feeder 6 and/or the receiving table 7 to be adjustable.

[074] Figures 7 to 9 illustrate individual bristles 12 of the brushes 3. In a simplified illustration, the bristles 12 are represented as having a straight profile. However, in an advantageous embodiment it is possible to provide for the bristles 12 to have a wavy or twisted profile, so that the bundles 120 formed by the bristles 12 resemble a tangled paintbrush or a tuft.

[075] In the exemplary embodiment shown in Figs 7 to 9, the conveyor device 2 is provided with a V-belt 13. As an alternative to the V-belt 13, it is also possible to provide a toothed belt, a flat belt with studs, a chain, a strip or the like. In the exemplary embodiment illustrated, the V-belt 13 is designed as a "triple" V-belt 13 with two outer V-belts 13b, 13c and a middle V-belt 13a. The middle V-belt 13a is intended to accommodate the brushes 3.

[076] The V-belt 13 may be formed from rubber, plastic, synthetic rubber or preferably from neoprene. In general terms, it is possible to provide for the brushes 3 or the bristles 12 to be adhesively bonded, molded, screwed, stamped or welded to the V-belt 13. In the exemplary embodiment, it is provided that a PU (polyurethane) covering layer 14 has been applied to the V-belt 13. Consequently, it is possible for a carrier 15, which is preferably formed from rubber or plastic (e.g. neoprene), for the brush 3 or bristles 12 to be welded on in a simple way. This produces an advantageous and reliable join. The thickness of the PU layer 14 may be from 1 to 5 mm, preferably 2 mm.

[077] The V-belt 13 may be provided with a plurality of individual brushes 3 (Fig. 6) or with a single brush 3 which completely covers the V-belt 13 (Fig. 17).

- [078] The bristles 12 can be shot into the carrier 15 in bundles 120. This ensures secure and reliable joining both of the carrier 15 to the V-belt 13 and between the carrier 15 and the shot-in bundles 120. A reliable join is imperative on account of the high rotational speed and the forces which are generated. As a result, it is possible to run at high brush speeds. The design of the conveyor device 2 as a belt drive with a V-belt 13 runs smoothly and reliably.
- [079] For the bristles 12 or the bundles 120 to be shot in in an advantageous way, it is possible for the bristles 12 to be provided with barbs (not shown in more detail). In the exemplary embodiment, the V-belt 13 is designed as what is known as a Powerband. Tests have shown that the outer two V-belts 13b, 13c are sufficient for driving purposes, so that the middle V-belt 13a can be used to accommodate the bristles 12 without problems.
- [080] As can be seen from Figures 7 to 9, the carrier 15 is provided with slots 16 running transversely with respect to the direction of rotation of the conveyor device 2 or the V-belt 13. Alternatively, the carrier 15 may, in a manner which is not illustrated, also be formed from individual segments of similar dimensions. It is possible to provide for the slots 16 to form pieces 15a of the carrier 15 with a length of from 10 to 40 mm. In the exemplary embodiment, it is provided that both the length and the width of the pieces 15a are 18 mm. Each piece 15a in this case receives a bundle 120 of the bristles 12. In each case three pieces 15a together form a brush 3. Of course, other configurations are also conceivable in this context, by way of example it is possible for in each case two or four pieces 15a together to form a complete brush 3. The number of bristles 12 per bundle 120 is not restricted to the number illustrated, but rather there is provision for a multiplicity of bristles to be combined to form a bundle 120.
- [081] As also emerges from Figures 7 to 9, two bristle-free pieces 15a are arranged between the brushes 3, formed from the bundles 120, of a V-belt 13. In this case too, a different number is conceivable. The distance which is created between the brushes 3 by the bristle-free pieces 15a ensures that a domino effect, i.e. an effect whereby the bristles 12 located at the front, as seen in the direction of rotation, push over the following bristles 12 before they reach the workpiece 1, and consequently the following bristles 12 can no longer stand up at all, is avoided.
- [082] The fact that the carrier 15 is divided into pieces 15a by the slots 16 results in a particularly small bending radius, so that the overall apparatus can be produced in a space-saving and inexpensive way.

- [083] According to the invention, it is possible to provide for the length of the bristles 12 to be from 30 to 90 mm, preferably 60 mm.
- [084] The carrier 15 may be formed from the same material as the V-belt 13. In this context, various embodiments are conceivable; these embodiments are suitable for shooting in the bristles 12 allowing them to be reliably welded to the PU covering layer 14.
- [085] Figures 10a to 10d show various advantageous embodiments of the V-belt 13. The V-belt 13 shown in Figs 10a to 10d in this case have elevations or protuberances 17, which are intended to guide and support the carrier 15, on their top side that is to be provided with the carrier 15. In this context, Fig. 10a shows a protuberance 17 which is triangular in cross section and runs parallel to the middle V-belt 13a. The carrier 15 which is to be connected to the V-belt 13 in accordance with Fig. 10a preferably has a cutout corresponding to the protuberance 17, resulting in a particularly reliable connection being formed between the carrier 15 and the V-belt 13.
- [086] Fig. 10b shows a particularly preferred embodiment of the V-belt 13, which is also illustrated in Fig. 11. The V-belt 13 shown in Fig. 10b has two protuberances 17 which are intended to laterally guide and support the carrier 15. The width of the carrier 15 or the distances between the protuberances 17 are in this case preferably matched to one another.
- [087] Fig. 10c shows an alternative embodiment of the protuberance 17 to that shown in Fig. 10a, likewise extending parallel to the middle V-belt 13a. The protuberance 17 creates a tongue-and-groove connection between the carrier 15 and the V-belt 13.
- [088] Fig. 10d shows a configuration of the V-belt 13 which is simplified compared to Fig. 10b and in which the carrier 15 is only guided and stabilized by a protuberance 17 on one side. As tests have shown, one lateral protuberance is sufficient to improve the connection between the carrier 15 and the V-belt 13.
- [089] The protuberances 17 shown in Figures 10a to 10d advantageously prevent rotation or rotary movement of the carrier 15.
- [090] The V-belt forms illustrated in Figures 10a to 10d can be produced in a simple and inexpensive way and are responsible for an additional positively locking connection of the carrier 15 to the V-belt 13.
- [091] Fig. 11 shows the V-belt 13, onto which a carrier 15, which is preferably formed from rubber or plastic, has been screwed, riveted, adhesively bonded, welded or clipped. The carrier 15, which is used to accommodate the brush 3 or the

bristles 12, is composed of segments 15b, two of which are illustrated by way of example in Fig. 11. In the exemplary embodiment, the distance between the segments 15b is 3 to 20 mm, preferably 6 to 10 mm. Of course, the segments 15b may also be arranged without a distance between them or with a greater distance between them.

[092] Fig. 12 shows an advantageous embodiment of the segments 15b. The segments 15b each have a groove 18 at one end and a tongue 19 at the other end, by means of which the segments 15b can be connected to one another. Twisting of the segments 15b is prevented in a simple and advantageous way by this tongue-and-groove connection.

[093] The segments 15b are illustrated without any bristles 12 in them in Figs 11 and 12, for the sake of clarity.

[094] Fig. 13 shows a segment 15b or a piece 15a of a carrier 15 with inserted bristles 12. The bristles 12 of the brush 3 are inclined by a maximum of up to 45°, preferably by 15°, in the direction of rotation. This means that the tips of the bristles 12 are located in front of the opposite end of the bristles, which is connected to the carrier 15, as seen in the direction of rotation. As tests have shown, the bristles 12 which are inclined by 15° penetrate into cutouts in the workpiece 1 in a particularly advantageous way, resulting in particularly advantageous removal of the oxide layer from cut surfaces 1b and cut edges 1a of the workpiece 1. Of course, it is also possible for the bristles to be inclined beyond 45°, but this may lead to jamming and damage to the bristles 12 as they penetrate into the cutouts in the workpiece 1.

[095] Fig. 14 shows a modification to the segment 15b illustrated in Fig. 13, with a supporting bristle 20. As tests have shown, the supporting bristle 20 stabilizes the obliquely positioned bristles 12 and thereby improves the penetration into cutouts in the workpiece 1 and is responsible for uniform descaling. In an advantageous embodiment, the supporting bristle 20 is designed to be shorter than the bristles 12. A perpendicular or right-angled arrangement of the supporting bristle 20 with respect to the surface of the carrier 15 or the surface of the segments 15b has proven advantageous for stabilizing and supporting the bristles 12. The supporting bristle 20 can be joined to the carrier 15 in a similar way to the way in which the bristles 12 are joined to the carrier 15.

[096] The bristles 12, illustrated in Fig. 13 and Fig. 14, of the brush 3 may advantageously be designed as intertwined bristles and/or as abrasive bristles. This has proven particularly suitable in tests.

- [097] Fig. 15 shows a segment 15b of the carrier 15 with a bundle 120 of the bristles 12 which is surrounded by a stabilizing and supporting sheath 21. The sheath 21 in this case serves as an alternative to the use of supporting bristles 20. As illustrated in Fig. 15, the sheath 21 extends from the bottom end of the bristles 12 to approximately the center of the bristles 12. This has proven particularly suitable for stabilization purposes without any risk of the sheath coming into contact with the workpiece 1.
- [098] Fig. 16 shows a V-belt 13 with an arrangement of segments 15b in accordance with Fig. 11, the segments 15b being provided with bristles 12 positioned obliquely at an angle of 15° in accordance with Fig. 13. This is a particularly preferred embodiment.
- [099] Fig. 17 shows an exert from a conveyor device 2, downstream of a diversion point 22, as seen in the direction of rotation, before the brush 3 or the bristles 12 come(s) back into contact with the metallic workpiece 1 in strip or plate form. A resistance element 23 is arranged in this region. The diversion point 22 is also illustrated in Fig. 2, for the sake of clarity. The diversion point 22 is to be understood as meaning the location at which the V-belt 13 is diverted round by the rolls, rollers or the like driving the V-belt 13. The direction in which the V-belt 13 moves is opposite before and after the diversion point 22. The inventor has discovered, in a way which was not obvious, that the bristles 12 yield inward downstream of the diversion point 22, as seen in the direction of rotation, and are only at a later stage able to stand up again in the intended way, preferably at an inclination of 15°. The inward yielding of the bristles 12 takes place in the region in which the brush 3 or its bristles 12 leave(s) the circular path of the diversion point 22 and merge into a linear or rectilinear movement. The inward yielding of the bristles 12 substantially results from the fact that they depart from the circular path of the diversion point 22 but the bristles 12 still bring sufficient momentum to effect a forward yielding movement.
- [100] The inventor has discovered that this forward yielding movement can be prevented by a resistance element 23. The resistance element 23 may preferably be designed in mechanical form as a steel roll, which can be introduced into the path of the brush 3 in such a manner that the tips of the bristles 12 come into contact with it, thereby eliminating the momentum which causes the bristles 12 to yield inward. The steel roll 23 may, as illustrated in Fig. 17, be arranged on a plate 24, which for its part is preferably arranged pivotably on a stationary housing part (not shown).

- [101] In a lying embodiment of the apparatus according to the invention, in which the bristles 12 project upward in the region of the workpiece 1 that is to be machined, the steel roll 23 can be placed onto the tips of the bristles 12 in a simple way by means of the plate 24, with the weight of the steel roll 23 and the plate 24 being sufficient to exert pressure. In other arrangements or if the bristles 12 project downward in the direction of the workpiece 1 to be machined, the pressure required can be easily generated in another way, for example by means of springs (not shown).
- [102] On account of the fact that the resistance element 23 prevents the brushes 3 and their bristles 12 from yielding inward, it is possible to uniformly and accurately machine the workpiece 1. As an alternative to a steel roll 23, it is also possible for any other desired resistance element to be introduced into the path of the rotating bristles 12, so that the bristles 12 come into contact with the resistance element accordingly, and the momentum is eliminated. In an alternative embodiment (not shown), the resistance element 23 may also be designed as a magnet, which is arranged in such a manner in the region of the diversion point 22 that the bristles 12 are prevented from yielding inward by the magnetic force of the magnet. In this case, it is advantageous for the magnet to be arranged in the region in which the bristles 12 yield inward after they have left the circular path. In this context, it may be advantageous if the magnet is arranged just before this region, i.e. behind it as seen in the direction of rotation, so that the magnetic force acts on the bristles 12 at an early stage and thereby pulls them back and counteracts the yielding movement.
- [103] Fig. 18 shows a particularly preferred embodiment of the apparatus according to the invention with four conveyor devices 2. The preferred arrangement of the conveyor devices 2 in terms of their direction of rotation has already been dealt with above. The preferred embodiments, which have likewise been dealt with in particular in Figures 10 to 17, will also not be considered in further detail with regard to Fig. 18. Fig. 18 shows a purely schematic illustration of the apparatus according to the invention, with the illustration reduced to the parts which are pertinent to the invention. Fig. 18 shows the apparatus according to the invention in a lying position, i.e. the workpiece 1 is introduced and pushed through in a lying position.
- [104] As has already been described, a sheet-metal feeder 6 is used to put the workpiece 1 in place. A receiving table 7 is provided for removal of the workpiece 1. Between the second and third conveyor devices 2 there is a base plate 9, which is used to guide the workpiece 1 stably through the apparatus. The sheet-metal

feeder 6, the receiving table 7 and the base plate 9 are designed, in the exemplary embodiment illustrated in Fig. 18, as table elements, of which the side edges running parallel to the direction of advance of the workpiece 1 are designed as a perforated metal sheet for receiving rolls 25 or rollers. On account of the fact that the table elements 6, 7, 9 are provided with a system of rolls, it is particularly easy for the workpiece 1 to be pushed through the apparatus transversely with respect to the conveyor devices 2. The system of rolls is significantly more robust and unsusceptible to damage caused by the workpiece 1 jamming compared to a rubber conveyor belt.

[105] For the workpiece 1 to be guided through, the apparatus according to the invention illustrated in Fig. 18 also has three advancing rollers 26. In the exemplary embodiment, the advancing rollers 26 comprise a metallic base body which is provided with a rubber covering. In a preferred embodiment (not shown in more detail), the rubber covering has a profile or ribbed contour, for example a cross-pattern. In this context, it is also possible to use other patterns, as are known, for example, from tire profiles. The sheath for the base body of the advancing roller 26 may consist of rubber or plastic. The advancing rollers 26 ensure uniform and reliable conveying of the workpiece 1 transversely with respect to the directions of rotation of the conveyor devices 2.

[106] As can be seen from Fig. 18, a brush guide 27, which is intended to prevent the brushes 3 from yielding or being displaced backward by the advancing movement of the workpiece 1, is arranged behind the bristles 12, as seen in the direction of advance of the workpiece 1. A smooth plastic, in particular an abrasion-resistant plastic, such as for example the special plastic known as S-Grün, is particularly suitable for use as brush guide 27.

[107] This easily prevents the brushes 3 or their bristles 12 from slipping backward, i.e. in the direction in which the workpiece 1 is pushed through.

[108] Tests have shown that particularly advantageous guidance of the V-belt 13 results from supporting rolls 28 being arranged at a distance of preferably 100 mm. The supporting rolls 28 prevent the V-belt 13 from being pressed away from the workpiece 1 to be machined. In this context, it has proven sufficient for the distance between the supporting rolls 28 to be 100 mm.

[109] For reasons of simplicity, Fig. 18 does not illustrate either the belt or a motor. However, a carrier 29 for the motor and the belt is illustrated. The solution according to the invention with four conveyor devices 2 as illustrated in Fig. 18 enables the whole of the workpiece 1 to be machined in one pass. There is no need to



reintroduce the workpiece 1. The speed at which the brush 3 or bristles 12 is (are) guided along the workpiece 1 is preferably 15 to 16 m/sec.

[110] Technical details, which are not described further, relating to the embodiment illustrated in Fig. 18 will emerge from the standing embodiment of the apparatus according to the invention which has been described with reference to Figures 1 to 5.

[111] The solution according to the invention can be produced with different machining lengths and/or different widths for the introduction of workpieces 1.